indicates that the assumption of milk intolerance by many populations is exaggerated. The methods for the diagnosis of these conditions were critically evaluated and it is suggested that, a) "physiological" doses of lactose be used; b) milk is the vehicle of choice; c) tests of intolerance be double-blind, and d) analysis of breath hydrogen be used for malabsorption. Most of the evidence indicates that milk consumption allows adequate growth of children, even when they are malnourished and have diarrhea. Nevertheless, it is recommended to substitute temporarily non-human milk by other good sources of dietary protein and energy during episodes of severe diarrhea, and to reintroduce milk to the diet gradually during convalescence. Breast feeding, however, should not be interrupted. There is not enough scientific nor epidemiological support to justify discouraging the use of milk in food supplementation programs, but several aspects that must be considered in such programs are outlined. (General conclusions and recommendations are presented in both English and Spanish).

INTRODUCTION

Milk is the main food consumed by infants of mammalian species. It has a high nutritional value in terms of protein, carbohydrate and fat, and breast milk is considered the most adequate food for human infants. In societies where prolonged breast feeding is the rule, children receive a substantial portion of their dietary protein and energy from milk up to 2 or 3 years of age. Cow's milk and milk-based formulas are also widely used in infancy and, especially in industrialized countries, throughout childhood. Milk is available in most parts of the world through local existence of dairy herds, commercial practices or food distribution and supplementation programs. The latter are usually directed not only at infants but also at preschool - and school - age children.

The carbohydrate of milk, lactose, is a disaccharide composed of glucose and galactose joined in a glycosidic 1-4 beta linkage. Humans cannot absorb disaccharides and lactose must be hydrolyzed into its component monosaccharides by neutral lactase, which is a membrane-bound enzyme present in the brush border of the small intestine's epithelial cells (1). Its activity is highest in the proximal ileum and very low in the first portion of the duodenum and in the terminal ileum (Figure 1). Lactase activity can decrease under various circumstances and, if sufficiently low, can produce maldigestion and malabsortion of

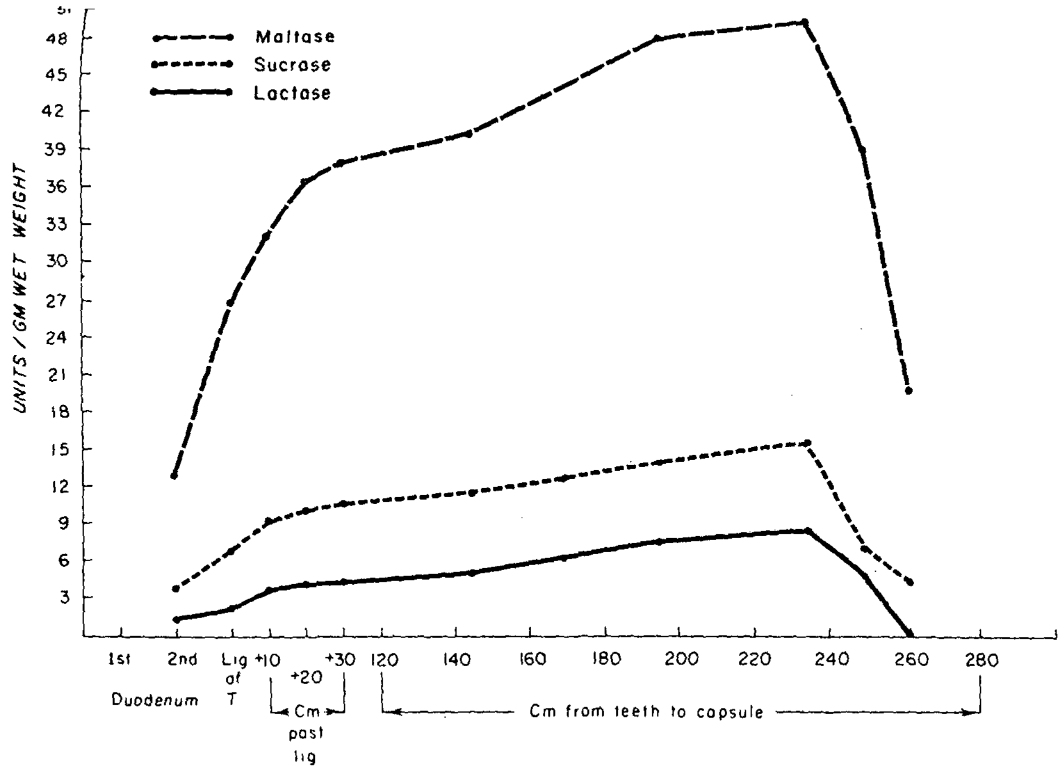

FIGURE 1

Distribution of disaccharidase activity in a normal subject, showing a gradual increase in the jejunum and a decrease in the distal ileum. Taken from Newcomer and McGill (8) lactose. This causes an abnormal response to an oral dose of lactose with or without clinical symptoms, such as meteorism, flatulence, borborygmi, abdominal pain and diarrhea.

Except for rare cases with congenital lactase deficiency (2-4) and for premature babies (5), infants and healthy young children are well equipped to metabolize lactose, since human milk is richer in this sugar than cow's milk (6) and contents of up to 9.5 g/100 ml have been reported (7). Table 1 shows a comparison of cow's milk and human milk composition for selected nutrients.

TABLE 1

COMPOSITION OF HUMAN AND COW'S MILK (PER 100 g)*

	Human	Cow's
Energy, Kcal	72	65
Protein, g**	1.3	3.5
Lactose, g	7.0	4.9
Fat, g	4.2	3.5
Calcium, mg	33	118
Phosphorus, mg	14	93

* Data from Jelliffe and Jelliffe (6), and USDA (7).

** "Apparent" protein content, based on assessment of total nitrogen.

Lactose malabsorption or intolerance has been termed "*primary*" when it occurs gradually as age progresses in normal children and in adults of various ethnic origins, and "*secondary*" when it follows an injury of the intestinal mucosa and associated diseases, including severe protein-energy malnutrition (PEM) (4, 9). Garza and Scrimshaw (10) suggested that the term "lactase deficiency" should be applied only to secondary lactose intolerance because primary intolerance appears to be normal for other animal species (11-13) and a majority of humans (14-19). The decrease in enzyme activity is a cause of concern to nutritionists because milk is frequently part of food aid programs for populations with a high prevalence of primary lactose intolerance, diarrheal diseases and protein-energy malnutrition. Such intolerance has been reported mainly after an oral challenge with large quantities of lactose in aqueous solution and it need not be related to intolerance to milk fed at usual doses (20-22). Nevertheless, the concern that the interplay of genetic, nutritional and other environmental factors among children in the developing world and among non-Caucasian children in industrialized countries might reduce their milk-digesting capacity early in life, has important public health and nutritional policy implications. Several groups of experts, such as the Protein Advisory Group of the United Nations System (23), the Food and Nutrition Board of the United States' National Research Council (24) and the Committees on Nutrition of the American Academy of Pediatrics (25, 26) agreed that there was no reason to discourage consumption of the amounts of milk ordinarily consumed by children, except during and shortly after acute gastroenteritis. Many scientific reports support those conclusions but a few investigators question them. Therefore, in the present paper we examine the scientific literature and our own experience at the Institute of Nutrition of Central America and Panama (INCAP), and we propose position statements on the use of milk and other lactose-containing foods for children.

DEFINITIONS

Any discussion of the indications and contraindications to the use of milk as a human food must consider certain terms of reference related to definitions and conditions. The proposed working definitions are:

a) *Lactose malabsorption:* The objective (documented) failure of small intestinal hydrolysis and complete absorption of an oral dose of lactose.

b) *Lactose intolerance:* The experience of clinical signs and symptoms including abdominal pain and bloating, meteorism, eructation, flatulence and/or diarrhea, following the oral ingestion of lactose.

The important distinction is that the former term refers to *objective* criteria of absorption, quantifiable in physiological indices, while the latter refers to *subjective* symptoms and clinical signs. Another confusing term is that of *milk intolerance*. This refers loosely to the occurence of symptoms after the ingestion of milk. In the individual with a pre-existing aversion to milk as a beverage, these symptoms are often psychologically based. Moreover, the physiological basis of milk intolerance is not always attributable to the maldigestion and malabsorption of its lactose, but also to allergic reactions to its protein constituents (27-31). Thus, it is important to evaluate the terms lactose malabsorption and lactose intolerance in a clear and consistent perspective, and to realize that not all untoward responses to milk consumption are due to its lactose content.

A second inescapable consideration relates to the *dose* of lactose used to evaluate the patient for either malabsorption or intolerance. The conventional carbohydrate dosage for an oral lactose challenge has been 2 g per kg of body weight up to a maximum of 50 g or 50 g per m^2 of body surface, in aqueous solution. This dosage must be considered pharmacological when judged in terms of the usual consumption of lactose-containing foods. For an adult, it is the equivalent of drinking the lactose content of one liter of cow's milk as a concentrated solution. The amount of lactose in an 8 oz (240 ml) glass of bovine milk is about 12 g, one-fourth of the customary adult lactose challenge. A 10 kg toddler consuming the same volume of milk at a given meal would receive 1.25 g of lactose per kg of body weight. Breast-fed infants would optimally consume around 850 ml of human milk with a lactose content of 50-60 g in 24 hours (6, 32). Assuming six or more feeding periods in the day, the single dose of lactose would rarely exceed 10 g. Thus, the only individuals for whom 2 g per kg approximates a physiological dose would be young infants who weigh 5 kg or less.

New analytical techniques allow the quantification of absorption of lactose doses in the physiological, dietary range. The findings from those studies are pertinent to the present discussion.

QUANTIFICATION OF LACTOSE MALABSORPTION

Malabsorption of dietary lactose is presumably due to an absolute, relative or functional deficiency of intestinal lactase. The direct and indirect diagnostic clinical tests developed to assess and quantify the intestinal capacity to absorb lactose are listed in Table 2.

TABLE 2

QUANTITATIVE AND SEMI–QUANTITATIVE METHODS USED IN THE EVALUATION OF LACTOSE ABSORPTION OR LACTASE DEFICIENCY

Post-lactose rise in plasma glucose (33-38)
Post-lactose rise in plasma galactose (35, 39, 40)
Breath $^{14}CO_2$ excretion following ^{14}C-lactose (33, 35, 41-44)
Stool excretion of ^{14}C following ^{14}C-lactose (42)
Post-lactose breath H_2 excretion (35, 42, 45-61)
Fecal pH and/or fecal reducing substances (62-66)
Barium-lactose meal radiography (67-69)
Intestinal perfusion with lactose (42, 70, 71)
Post-biopsy small bowel mucosal lactose hydrolysis *in vitro* (lactase assay) (8, 63, 72-79)

Blood Tests

The most commonly used test involves the *rise in plasma glucose concentration* following an oral dose of lactose. Plasma samples, usually from capillary blood, are taken at 0, 15, 30, 60, 90, 120 minutes with respect to ingestion of the dose. A rise of less than 25 mg/dl (some use 20 mg/dl) is considered as a "flat curve", corresponding to lactase deficiency (23). A more specific variation of this test uses the *rise in plasma galactose*. The chemical determination of galactose is more complex than that of glucose and the test as originally described employs a dose of ethanol with the lactose load (39, 40). This requirement limits the utility of the test in young populations.

Both tests require doses of 2 g/kg or 50 g/m^2, up to 50 g, of carbohydrate in order to achieve the expected threshold rise in postingestion plasma monosaccharide concentration. The increment in plasma glucose has been used occasionally following a lactose dose as milk (20), but slower gastric emptying velocity resulted in a lower peak glucose and the requirement for new, less discriminative criteria. Falsely abnormal plasma glucose tests are common in children with the oral administration of lactose, even with the standard aqueous dose, due to their variability of gastric emptying. The intraduodenal administration of lactose correlates better with intestinal lactase assays (80). In infants both false positive and false negative tests are frequent (36, 63). The requirement for repeated blood sampling, albeit of capillary blood, makes it a mildly invasive test and in societies such as the highland Guatemalan Indians, ethnic group where strong cultural objections to blood sampling prevail, other methods of assessing lactose absorption must be used.

Breath-Analysis Tests

The rate of *pulmonary excretion of* $^{14}CO_2$ after the oral administration of 5 μCi of ^{14}C-l-lactose ingested with a dose of unlabelled lactose (usually 50 g) has been reported. This test depends upon the digestion, absorption and oxidation of the carbohydrate. As other tests, it is influenced by glucose metabolism and gastric emptying. Moreover, unabsorbed ^{14}C-lactose can be oxidized by colonic bacteria and thus, influence the results (25). The use of radioisotopes may be contraindicated in children and women of childbearing age. An analogous test using Carbon-13, a nonradioactive, stable isotope of carbon, as the isotopic label on lactose, is currently being developed and validated by investigators at the University of Chicago and Johns Hopkins Medical School (81). Its application will probably be limited by the high cost of the stable isotope-labelled lactose (about US$18 per kg of body weight) and the need of a mass spectrometer for its quantification.

A test based on *pulmonary excretion of hydrogen gas* following a carbohydrate load has become increasingly popular. It is based on the fact that carbohydrates that are not absorbed by the small intestine are fermented by bacteria in the colon with the evolution of hydrogen gas (H_2). A fraction of the colonic H_2 is absorbed and excreted through the lungs (82). Samples of expired air can be obtained at intervals, stored for up to 7 weeks, transported or mailed in rubber-stoppered test tubes and analyzed rapidly by gas chromatography. This method has been widely applied to study lactose absorption (Table 2), including investigations in infants and children (49, 50, 53, 59, 61), thanks to the adaptation of simple techniques for exhaled gas collection from young subjects (61, 83-85). The advantages of this test are its non-invasive and non-isotopic nature, its low cost, and the fact that lactose doses in the usual dietary range (i.e., 10-12.5 g) can be used since the test can determine the malabsorption of as little as 2 g of carbohydrate (46, 61). Moreover, lactose can be administered as milk (47, 50, 58-60) without the usual problems of variability of gastric emptying, as the overall collection period can be appropriately extended. However, a number of pitfalls in the use of the H_2 breath test have been identified: an artifactual rise in H_2 concentration is seen if the subject being tested is allowed uninterrupted periods of sleep (61, 86, 87); some individuals do not possess a suitable colonic flora to ferment lactose (46, 88); and, antibiotics can influence the production of H_2 from carbohydrate substrates (61, 89). Moreover, the elimination of H_2 in the breath for a given quantity of nonabsorbed carbohydrate is reduced during episodes of active diarrhea (90).

Fecal Analysis Tests

The classical fecal analysis tests to determine lactose malabsorption are the measurements of *stool pH* and/or *fecal reducing sugars.* Neither of these procedures requires sophisticated or expensive aparatus; Litmus paper and Clinitest ^{R} tablets (Ames) are sufficient reagents. The test has been recommended by some authors (63, 64) as the only reliable indirect parameter of lactose malabsorption in infants. The test is inherently qualitative, as stool dilution influences the concentration of both hydrogen ions or fecal-reducing substances. Furthermore, it should be remembered that breast-fed infants normally excrete some quantities of lactose in their stools and normally have an acidic stool pH (91). In addition, slower intestinal transit and the ability of the child to control colonic discharge with increasing age, reduce the utility of these simple stool indices in mild-to-moderate degrees of lactose malabsorption.

Bond and Levitt (42) followed the fecal *excretion of* ^{14}C administered with 12.5 g of lactose in their $^{14}CO_2$ breath test. They found that stool ^{14}C excretion grossly underestimated lactose malabsorption with less than a quarter of the nonabsorbed isotope appearing in the feces. This is undoubtedly explained on the basis of further bacterial action on unabsorbed substrate in the colon with its metabolism to $^{14}CO_2$, or short-chain fatty acids which were partially reabsorbed (92).

Radiographic Methods

In 1967, Laws, Spencer and Neale (67) introduced a lactose absorption test based on the radiographic dilution of a dose of barium administered with a lactose load. It has found little popularity, but two recent reports revived the methodology (68, 69). The administration of pharmacological doses of lactose with a barium meal seems to be an inherently unphysiological situation. This fact, coupled with the radiation exposure from fluoroscopy and radiography, should preclude its use in children and pregnant women and discourage its application in the rest of the population.

Intestinal Perfusion

One of the more precise and sophisticated modern physiological tests of lactose absorption is the intestinal perfusion using a nonabsorbable marker (e.g., polyethylene glycol) as a reference of substrate disappearance and water movement. The lactose can be administered in dietary or supradietary amounts, either orally or intraintestinally, and its rate of disappearance, measured over a segment or over the entire length of the small intestine. It has been applied in children using natural substrate (70, 71), and in adults using ^{14}C-isotopically-labelled ^{14}C-lactose (42). The invasive nature of intestinal intubation with its frequent requirements for fluoroscopic placement, and the optional use of radiocarbon substrate, are strong deterrents to its routine or widespread use. However, it is the most precise and directly available index of the intestinal capacity to absorb lactose and *must be considered the standard* for all functional tests, although it does not take into account gastric emptying.

Lactase Assay

The *in vitro* determination of the lactose hydrolyzing capacity of intestinal mucosa obtained by peroral biopsy (lactase assay) has been widely used as the standard for intestinal lactose absorption. This is a test of enzyme specific activity and not of *in vivo* absorptive function, although it has been presumed that reduced, deficient or absent lactase levels in a biopsy of the proximal jejunum correlates with the capacity to digest and absorb dietary lactose. A content of less than 2 lactase units (µmoles of substrate hydrolyzed/min at 37°C) has been considered to represent lactase deficiency. In at least one age group, infants, lactase levels failed to correlate with other indices, notably fecal reducing substances, in subjects with evidence of lactase malabsorption (63). Moreover, whether or not the lactase activity of a given biopsy sample is representative of the enzyme distribution throughout the entire jejunum in all individuals has not been settled as yet. In the final analysis, the lactase assay is a tissue standard for the physiological tests of absorptive function but it is too complicated and invasive for routine use at population level.

Comparison of Various Methods

A number of recent studies have compared the performance of various tests (33, 35, 42, 93). Arvanitakis *et al.* (33) compared the plasma glucose test and the ^{14}C-lactose breath test with a 50 g lactose load against the jejunal lactase assay; the breath test was 100o/o specific and resulted in only one false negative test. Newcomer *et al.* (35) compared the rise in plasma glucose, the rise in plasma galactose, breath $^{14}CO_2$, and breath H_2 following a 50 g lactose dose with the jejunal biopsy lactase activity in 25 lactase-deficient and 25 normal adults. False negative results were uncovered in 1, 2, and 6 individuals with the galactose, $^{14}CO_2$ breath test, and glucose tests, respectively; in normal subjects, there was only one false positive result, occurring with glucose rise as the index. The H_2 breath test proved to be 100o/o sensitive. Using a dietary dose (12.5 g) of oral lactose, and an ileal perfusion system as the standard of absorption, Bond and Levitt (42) found breath H_2 excretion to correlate much more closely than breath $^{14}CO_2$ or fecal excretion of the isotope. The traditional plasma glucose test, on the other hand, gave a substantial incidence of false negative and occasional false positive results. The general conclusion is that the H_2 breath test is the most reliable indirect index of lactose malabsorption currently available.

QUANTIFICATION OF LACTOSE INTOLERANCE

Since the criterion of lactose malabsorption, *per se,* may not be a definitive contraindication to milk consumption, the crux of the argument revolves around the prevalence and impact of lactose intolerance. But the evaluation of lactose intolerance is difficult because of its inherently subjective nature, either on the part of the subject, or of the observer. With adults, interviews can be conducted and the experience and intensity of symptoms in response to lactose ingestion can be elicited. The reliability of the data depends upon the rapport between interviewer and subject and, in bilingual situations, on a full appreciation of the subtleties of language. Alternatively, a written questionnaire with formal questions about symptom frequency and intensity can be presented to literate subjects. Reliance on intensity scoring is hazardous, as individuals vary in their perception and tolerance of pain and discomfort. Psychological influences of the subject and/or bias by the observer are uncontrollable in the standard test, in which no attempt is made to disguise the identity of the milk or lactose solution. The most reliable data on tolerance are obtained when identically flavored non-lactose and lactose-containing foods are presented in a double-blind manner as in the studies of Newcomer and associates (56) and of the group at M.I.T. (10, 94, 95). The latter studies are of critical importance as they reveal the unreliable nature of responses to symptoms after lactose ingestion. Inappropriate responses, such as symptoms with both lactose-containing and lactose-free preparations, symptoms only with the lactose-free beverage, and symptoms with the higher but not with the lower dose of lactose, were noted in about half of the respondents (94, 95). When these data were analyzed adjusting for inconsistent, inappropiate responses, only a 0-5% incidence of "true" intolerance was detected. The inconsistencies can only be noted when the content of the test substances is disguised. Furthermore, the overstated or understated nature of the questions in the questionnaire can also influence the response rate (95). Lacassie, Weinberg and Mönckeberg (96), in Chile, performed sophisticated regression analyses on 436 conventional lactose tolerance tests using 50 g of lactose in water and found that symptoms were a very poor predictor of the adequacy of glucose rise with a correlation coefficient of only 0.008. A potentially objective adjunct to the assessment of lactose intolerance would be the quantitative evaluation of bowel sounds (borborygmi) following a lactose load using the ingenious abdominal microphones and computerized analysis of sound recordings developed by gastroenterologists in Montreal (97, 98). This, however, may be available only to a limited number of investigators working in well-equipped research institutions and hospitals.

Intolerance is perhaps easier to evaluate reliably in the infant and young toddler. The experienced mother' and pediatrician can evaluate intolerance to a meal from the post-prandial behavior of the infant or young child. The child who appears distressed and colicky is suspect of having intolerance. Clinical signs such as intestinal distension, accentuated borborygmi, diarrhea and oral or rectal release of gas can all be determined by careful observation of the child.

Regardless of the degree of objectivity achieved in the evaluation of lactose intolerance, the fact remains that, from a practical point of view, milk or other lactose-containing foods should be used as the test meal in amounts which are likely to be ingested by the individual under normal dietary conditions. The response to an unusually high lactose challenge and conditions of gastric emptying such as those after ingesting an aqueous solution of sugar while fasting, may not reflect the events following a "normal" lactose-containing meal. In addition, the meaning of a single test meal to label an individual permanently as "intolerant" requires examination. For example, it is a well-known fact that severely malnourished children frequently have watery or loose stools when dietary treatment begins or a new food is introduced. The diarrhea improves in most of these patients as the treatment is continued, and usually there is an excellent clinical response accompanied by adequate growth (99, 100; Torún and Viteri: unpublished observations). Therefore, if lactose intolerance were to have important clinical nutritional implications, the diagnosis should be based on the persistence of symptoms after several days of using lactose-containing meals, since many malnourished children regain their ability to tolerate lactose with protein refeeding (101, 102). Otherwise, the possibility of a transient, self-limited episode of lactose intolerance should be acknowledged, and the patient not branded as lactose-intolerant for life.

PREVALENCE OF LACTOSE MALABSORPTION AND LACTOSE INTOLERANCE IN CHILDHOOD POPULATIONS

As the primary focus of this paper is the use of milk and lactose-containing foods in children, it is important to define the apparent magnitude of the problem in childhood populations. Despite the fact that the published literature would seem to present impressive evidence of widespread problems with lactose handling among non-white children in both industrialized and pre-industrial nations, several important considerations must be kept in mind. Firstly, the majority of the studies cited below were performed using either plasma glucose determinations, or stool pH, or reducing substance criteria; the level of sensitivity and specifity of these indices has been discussed. Moreover, the challenge dose of lactose was almost always in the pharmacological range (i.e., 2 g/kg) and fed as a concentrated aqueous solution while fasting. The nutritional consequences of the scientific reports reviewed must then be considered carefully in light of our present understanding of the assessment of "malabsorption" and the correct interpretation of "intolerance". Furthermore, when considering young children it is important to make a clear distinction between two different types of impaired lactose digestion: 1) "secondary" lactose malabsorption, which is acquired due to a pathological insult to the gastrointestinal tract, as with acute gastroenteritis or PEM; and 2) "primary" lactose malabsorption, which is genetically determined. The former is generally transient and acute; the latter, evolutionary and permanent.

Among the precipitating factors of secondary malabsorption, PEM is a common cause of nutritional injury to the alimentary tract. It is associated with morphological changes in the small intestinal mucosa (103-107) and lactase deficiency and/or lactose malabsorption has been demonstrated to occur in children with severe PEM (61, 101, 108-124). In our experience, lactose absorption improves with nutritional recovery (unpublished observations), but Leslie, MacLean and Graham (118) suggested that an episode of severe early malnutrition may hasten the development of permanent lactase deficiency. Other precipitating environmental factors are poor personal hygiene, underdeveloped sanitary facilities, and fecal contamination. Weaning is associated with an increased incidence of infantile diarrhea throughout the developing world (125) and abnormal lactose absorption has been associated with acute gastroenteritis in children (65, 70, 71, 105, 126-133). Giardiasis has been shown to predispose to lactose malabsorption in adult subjects, and it is likely that this would occur in infested children as well (134). In adult subjects, "tropical enteropathy" has been reported to predispose to lactase deficiency (135); this may also be a factor in children living under the same environmental conditions.

As with adults from non-European races (136), a very high prevalence of lactose intolerance and/or malabsorption has been reported in children throughout the world (Table 3). The large majority of studies involved children from the population-at-large, without clinical malnutrition or apparent gastrointestinal disease. Several of the reports cited in the Table suggest an

TABLE 3

PREVALENCE OF MALABSORPTION OF AND/OR INTOLERANCE TO PHARMACOLOGICAL DOSES OF LACTOSE AMONG CHILDREN FROM VARIOUS ETHNIC ORIGINS

Population origin	Age	Lactose dose	Diagnostic test (s)	Proportion of "malabsorbers" or "intolerant", %	Reference No.
Ugandan	3-4 yr 4-6 yr 7-9 yr	2 g/kg	Plasma glucose	60 100 100	(137)
Thai	1 mo-6 yr	3 g/kg	Plasma glucose	43	(140)
Singapore	1-15 yr	2 g/kg, up to 50 g	Plasma glucose and/or jejunal biopsy	66	(141)
Thai	<2 yr	2 g/kg	Plasma glucose	22	(123)
Nigerian Yoruba, Hausa and Fulani	1.5-3 yr	2 g/kg	Plasma glucose	99 (Y) 64 (H and E)	(142)
Indonesian	1-6 yr	2 g/kg	Plasma glucose	72	(143)
Peruvian	10 mo-17 yr	50 g/m^2	Plasma glucose	84	(102)
Nigerian	2-12 yr	2 g/kg, up to 50 g	Plasma glucose	79	(119)
Indian	7 mo-7 yr	2 g/kg	Blood glucose	40	(21)

(Cont.)

TABLE 3 (Continuation)

Ethiopian	1-13 yr	2 g/kg	Plasma glucose	80	(138)
Indonesian	< 1 mo 1-12 mo 12-36 mo	Not stated	Fecal pH and fecal reducing substances	33 44 41	(144)
Indonesian	1-6 yr	2 g/kg	Plasma glucose	72	(122)
Jamaican	2 mo-4 yr	2 g/kg	Plasma glucose	56	(120)
United States blacks	4-9 yr	2 g/kg	Plasma glucose and symptom score	48	(10)
Mexican-American	2-14 yr	2 g/kg	Plasma glucose and symptom score	37 malab., 41 intol.	(145)
Thai	1-17 mo	2 g/kg	Plasma glucose	> 60	(139)
United States blacks	13-59 mo	2 g/kg	Plasma glucose	29	(146)
United States Indians	5-17 yr	2 g/kg	Breath H_2 excretion	68	(57)
Egyptian	6 mo-12 yr	2 g/kg	Plasma glucose, fecal pH and fecal reducing substances	39	(112)
Zambian	3-84 mo	2 g/kg	Plasma glucose and symptoms (diarrhea)	33 malab., 71 diarrhea	(147)

increasing prevalence with advancing age from the neonatal period through adolescence, indicative of primary malabsorption (102, 112, 119, 137-139).

CORRELATION BETWEEN LACTOSE MALABSORPTION AND LACTOSE INTOLERANCE

Several investigators have explored the relevance of an abnormal response to a pharmacological dose of lactose and its interpretation in terms of the ability to tolerate usual dietary amounts of lactose. A select literature is available on the response of individuals identified as lactose malabsorbers after a challenge with a pharmacological dose, but in whom dietary doses were also administered to evaluate the symptoms. Table 4 cites studies for all age groups in which symptomatology was evaluated in response to a 10-15 g dose of lactose. The citations have been ranked in descending order of prevalence of symptomatic individuals. Prevalence of intolerance to physiological doses was quite variable ranging from 75% at the upper extreme (72) to 0 in five reports (10, 94, 95, 148, 149). The inclusion of individuals who were previously aware of their milk intolerance can explain in part the discrepancy among the results. Another important factor is the fact that so few studies were conducted in a double-blind fashion or even with any attempt to disguise the contents of the test beverages; recent publications, discussed above, emphasize the interpretative dangers of non-blind studies (94, 95) and the general poor correlation between malabsorption and intolerance (96).

Nonetheless, the majority of the data suggests that most individuals who are classified as lactose malabsorbers on the basis of a standard lactose load (2 g/kg or 50 g), can consume dietary amounts of lactose without experiencing symptoms of intolerance.

Another important factor related to the subjective experience of symptoms of intolerance is the *vehicle* used for lactose delivery. The rates of gastric emptying and intestinal transit may be crucial for the production of symptoms in an individual with a low intestinal lactase capacity. Firstly, a slower rate of delivery of substrate to the remaining enzyme would theoretically result in more effective hydrolysis. Secondly, even in the absence of hydrolysis the slower entry of osmotically-active substrate into

TABLE 4

PREVALENCE OF INTOLERANCE TO PHYSIOLOGICAL DOSES OF LACTOSE AMONG "LACTOSE MALABSORBERS" OF VARIOUS ETHNIC ORIGINS

Origin	Age	Basis for inclusion in study*	Amount of lactose and form of the "physiological" challenge	Per cent with intolerance symptoms	Reference No.
United States 80o/o blacks	18-17 yr	A	12 g in water	75	(72)
United States	"Adults"	B	12 g as 240 ml of low-fat milk	59	(150)
Danish	18-60 yr	C	15 g in lactose-hydrolyzed milk	45	(151)
United States blacks	11-18 yr	B	12 g in water 12 g as 240 ml of whole milk	42 42	(152)
Mexican	15-40 yr	B	12.5 g as 250 ml of whole milk	37	(153)
United States	13-19 yr	B	12 g as 240 ml of whole milk	14	(154)
United States 50o/o blacks	"Adults"	B	15 g in water 15 g as 250 ml of non-fat milk	7 20	(22)
United States native Indians	5-62 yr	D	12 g in Ensure ^{R} formulated diet	12**	(56)
Ethiopian	6-10 yr	F	12.5 g as 250 ml of whole milk	11	(138)

(Cont.)

TABLE 4 (Continuation)

Alaskan Eskimos	25-59 yr	F	10 g in water	5	(155)
United States	14-19 yr	B	10.8 g as a 4.5⁰/o solution in a chocolate drink	5**	(95)
Indian	21-67 yr	B	10 g in water	3	(156)
United States	14-19 yr	B	10.8 g as 4.5⁰/o solution in a chocolate drink	0**	(94)
Indian	7 mo-7 yr	B	1 g per kg body weight in water	0	(21)
Kenyan	5-15 yr	B	12 g as 240 ml of skimmed milk	0	(148)
United States	4-9 yr	F	12 g as 240 ml of whole milk	0**	(10)
United States	60-97 yr	E	10.8 g as 4.5⁰/o solution in a chocolate drink	0**	(149)

* A: Biopsy-proven lactase deficiency.
B: "Flat" blood glucose curve after aqueous solution of lactose, 2 g/kg or 50 g/m^2, up to 50 or 100 g.
C: "Flat" blood glucose curve after aqueous solution of 100 g lactose.
D: Excess breath H_2 excretion after aqueous solution of 2 g lactose/kg, up to 50 g.
E: Excess breath H_2 excretion after aqueous solution of 25 g lactose.
F: Racial susceptibility.

** Tests conducted in a double-blind manner.

the bowel would provoke a less abrupt, dramatic secretory response. The traditional studies with oral lactose have been conducted not only with doses in the pharmacological range, but also as aqueous solutions which would be expected to be emptied from the stomach much more rapidly than fat – or protein-containing meals. Leichter (20) drew attention to the lesser symptomatology experienced by adults with lactose malabsorption following the ingestion of whole milk as compared to skim milk, and with skim milk as compared to aqueous solutions with doses of 50 g of lactose (equivalent to 1,050 ml in the case of fluid milks). The same phenomenon was observed when the dose of lactose was reduced by 50o/o. Garza and Scrimshaw (10) found a low incidence of symptoms in lactose-malabsorbing black school children who received a 12 g lactose dose in a peanut butter and jelly sandwich. In these two studies (10, 20) the transit of lactose into the small intestine would be slower with the liquid or solid meal than with an aqueous solution.

Using the H_2 breath-analysis test, we have recently demonstrated that the production rate of H_2 from the same amount of carbohydrate is significantly slower in lactose-malabsorbing preschool children when lactose is given as whole milk than as an aqueous solution at a dose of 1.75 g/kg (59). Figures 2 and 3 illustrate this phenomenon in a child with persistent lactose malabsorption studied at INCAP's Clinical Research Center. A hydrogen breath-analysis test as previously described (85) was used. On two occasions, pairs of tests involving ingestion of 1.75 g/kg of lactose, either as aqueous solution or as whole milk, were performed. The rate of H_2 production in the 6 hours following the dose was slower with the milk test (Figure 2). When the dose was reduced to a more physiological level (0.88 g/kg), H_2 production was correspondingly reduced and, once again, a difference between aqueous lactose and milk could be appreciated (Figure 3). Douwes, Fernández and Rietveld (49) demonstrated a much earlier appearance and higher peak production of H_2 in children with lactose malabsorption and symptoms of intolerance, than in children with lactose malabsorption but no symptomatology after a 2 g/kg oral lactose challenge, confirming that the rate of gastrointestinal transit of the non-absorbed carbohydrate plays a role in the production of intolerance symptoms.

From these considerations of dosage and dietary form, we conclude that even though lactose malabsorption or lactase deficiency can be documented objectively by indirect physiol-

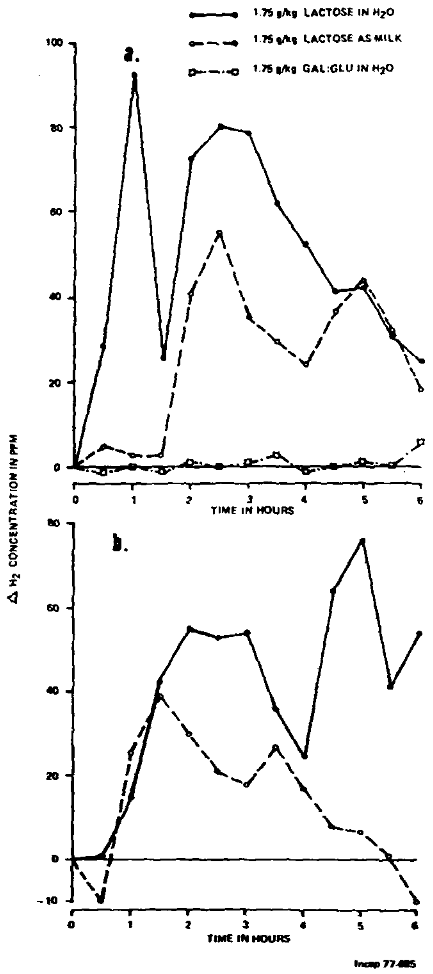

FIGURE 2

Changes in breath H_2 concentration after administering 1.75 g of carbohydrate/kg to a lactose-malabsorbing preschool child admitted to INCAP's Clinical Center with severe, acute PEM. The upper figure (a) shows the response to aqueous lactose, whole milk, and an equimolar glucose-galactose mixture when the subject was in mid-recovery. The lower graph (b) illustrates the response to aqueous lactose and whole milk after full nutritional recovery. The important features include the persistence of lactose malabsorption despite nutritional recovery, and the greater evolution of hydrogen in response to an aqueous solution than to a milk meal

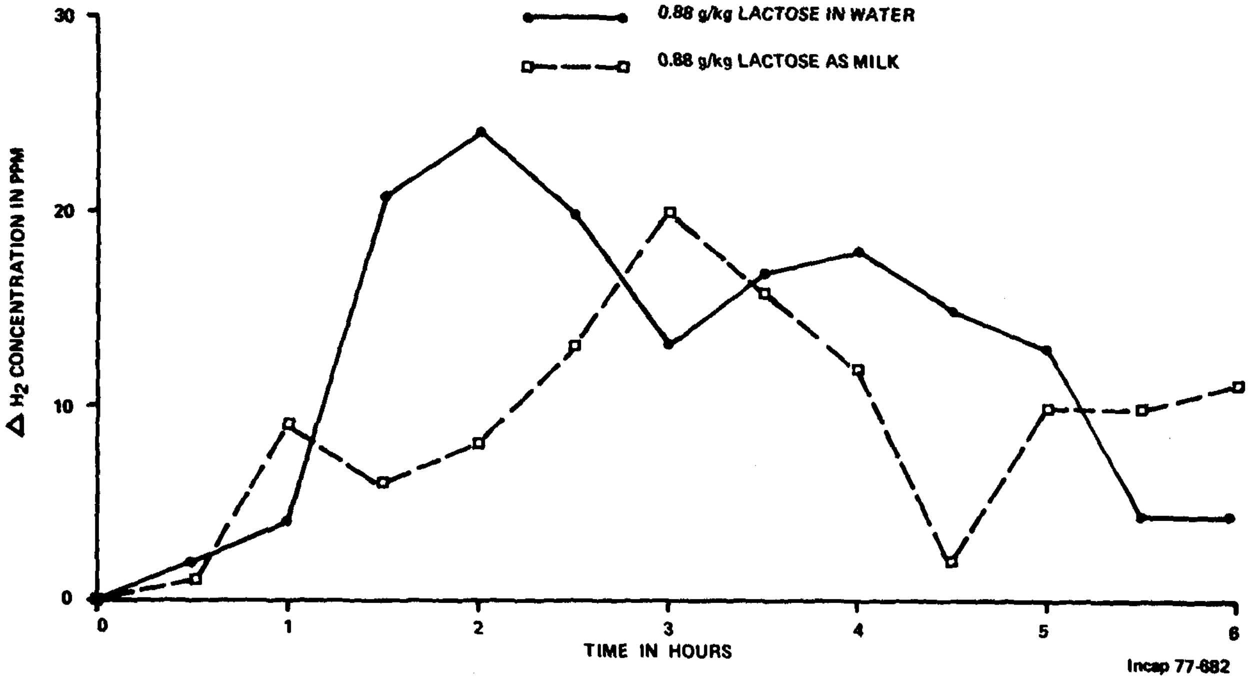

FIGURE 3

Changes in breath H_2 concentration after administering 0.88 g of carbohydrate/kg body weight to the same child shown in Figure 2, after he had achieved full nutritional recovery. The breath H_2 response is considerably decreased as compared with the higher lactose dose (shown in Figure 2). Once again, a greater evolution of H_2 *is seen with aqueous* lactose than with whole milk ogical procedures or direct small bowel biopsy, the potential for intolerance symptoms will be considerably less if the lactose is given in customary dietary amounts and as part of a meal than under the artificial setting of a concentrated aqueous solution. Thus, the prediction of the response of an individual or of a population to lactose-containing foods can very often be misleading when it is based on conventional clinical or laboratory diagnostic tests of lactose intolerance and/or malabsorption.

NUTRITIONAL IMPLICATION OF LACTOSE–CONTAINING FOODS

Nutrition and Growth of Healthy Children

The high prevalence of intolerance to a large test dose of lactose has prompted various groups of experts to evaluate the existing evidence and to state whether the use of milk in supplementary feeding for children should or should not be continued (23-26). Their conclusions in favor of the use of milk are supported by numerous studies which showed that many people with an abnormal response to a pharmacological dose of lactose can consume nutritionally significant amounts of milk without the development of symptoms (10, 20-22, 155-160). Over the past 25 years many preschool-age Guatemalan children of Mayan and Caucasian origins have been treated at INCAP for protein-energy malnutrition with milk-based diets, and they continued consuming similar diets under constant surveillance for several months after achieving an optimal nutritional status (unpublished observations). When fully recovered, lactose intakes were of the order of 3.5 to 6.5 g/kg of body weight divided into 4-6 daily meals, equivalent to a total daily intake of 70-130 ml of cow's milk/kg. The milk intake was tolerated well and their growth rates continued as expected for healthy, well-nourished children of the same ages and body sizes. Longitudinal studies among preschoolers in Thailand (139), school-age children in Surinam (161) and rural populations in Haiti (162) also indicate that milk-fed children from population groups with a high prevalence of lactose malabsorption grow as well or better than their non-milk consuming counterparts, and that milk consumption does not impair their nutritional status.

Investigators from Johns Hopkins University (102, 163-165) have reported that lactose intolerance may lead to milk rejection by some economically disadvantaged school-age children. This might hinder attempts to upgrade their nutritional status with milk supplementation programs. Other investigations, however, indicated that there were no differences in the milk drinking habits of tolerant and intolerant children (10, 21, 120, 145, 146, 166, 167). It has also been mentioned that some nutrition supplementation programs using milk as the main food have been rejected in Latin America because many children developed diarrhea (168, 169). These reports, however, do not indicate whether the rejection was documented quantitatively nor its duration. Furthermore, the preparation and consumption of the supplements under poor hygienic conditions could also be the cause of diarrhea.

Milk in the Treatment of Protein-Energy Malnutrition (PEM)

Much attention has been given to the effects of milk-based diets in the treatment of PEM since malnourished children have a very high prevalence of lactase deficiency and/or lactose malabsorption and intolerance (61, 101, 108-124). Adequate responses with milk as the main or only protein source in the therapeutic diets have been reported by various investigators (99, 100, 170-172). The amounts of milk fed to these children usually start at 1-2 g protein/kg and are gradually increased to 3-6 g milk protein/kg divided into 5-7 meals, which is equivalent to 0.3-0.6 lactose/kg/meal at the beginning, and to 1-1.7 g lactose/kg/meal at full treatment. Diarrhea has been observed in some children during the early stages of treatment, but it has seldom been demonstrated to be related to the milk ingestion nor to impair the child's water and electrolyte equilibrium, and in most instances it is self-limited, disappearing as the child's nutritional status improves. In our own experience, the treatment with milk of severely malnourished Guatemalan patients from Mayan, Caucasian or mixed ethnical origins rarely produces milk-related persistent diarrhea, and nutritional status improves adequately even in the occasional instances when this has occurred. Table 5 shows the rate of catch-up weight gain of 24 children aged 14 to 66 months admitted to INCAP's Clinical Center with edematous PEM (kwashiorkor or marasmic-kwashiorkor), randomly selected among those who were treated exclusively with a milk formula which provided 3-4 g protein, 5-6.7 g lactose and 150 Kcal/kg/day divided into 5-7 meals. During the preceding 4-12 days the

TABLE 5

CATCH–UP WEIGHT GAINS OF 24 CHILDREN WITH PROTEIN–ENERGY MALNUTRITION TREATED AT INCAP'S CLINICAL CENTER WITH COW'S MILK FORMULAS FOR 20–49 DAYS*

Severity of PEM at the beginning	No.	Age, months	Initial wt-for-ht, per cent of expected**	Weight gain, g/day	Weight gain, g/kg/day
Weight-for-height $<$ 80% of expected**	12	26 ± 6*** (14 – 37)	76 ± 2 (70 – 79)	76.6 ± 15.5 (58.1 – 100.0)	8.7 ± 1.7 (6.3 – 11.4)
Weight-for-height $\geqslant$ 80% of expected**	12	29 ± 13 (18 – 66)	84 ± 3 (80 – 88)	79.0 ± 32.1 (39.5 – 151.9)	7.8 ± 2.3 (4.1 – 12.1)
TOTAL	24	28 ± 10	80 ± 5	77.7 ± 24.7	8.2 ± 2.0

* The diets provided 3-4 g protein, 5-6 g lactose and 150 Kcal/kg/day, and they were fully consumed by the children.

** Relative to 50th percentile of well-nourished standards; weights after disappearance of edema.

*** Mean ± SD. Range within parentheses.

children drank milk formulas which gradually increased from 1 g protein and 100 Kcal/kg/day. The average weight gain was 12 times that expected for normal children of the same size allowing, therefore, an excellent catch-up. Recovery was also excellent, as based on clinical, biochemical and other anthropometric criteria. Similar rates of catch-up growth using milk have been reported among severely malnourished children from other countries, such as Ethiopia and Uganda (171).

Most of the doubts that have been cast on the beneficial effects of milk for the treatment of PEM are based on the high prevalence of abnormal lactose tolerance tests among malnourished patients and on the possibility that such intolerance may be partly responsible for the diarrhea of kwashiorkor (110, 116, 173, 174), albeit without indications that the intolerance is associated with impaired nutritional recovery or growth. Some investigators have suggested that the lactose in milk can be deleterious to malnourished children (9, 169, 175-177) but only the Australian investigators have provided quantitative experimental data (176, 177). They compared the rates of weight gain of aboriginal children, aged 1 to 37 months, who were admitted for a variety of reasons to two Australian hospitals for 6-57 days and fed either "normal" or lactose-hydrolyzed milk. They concluded that weight gain was slower with normal milk, but they used periods as short as 6 days (maximum 21 days) to assess weight changes, and they did not state whether the total energy intake and other factors which may affect weight gain (e.g., cause of hospitalization, hydration, fever, diarrhea, vomiting, etc.) were similar in both groups. Furthermore, since the children were grouped based on weight-for-age and they had been hospitalized for unspecified miscellaneous reasons, it is difficult to assess their actual degree of malnutrition and to establish if it was comparable in both groups.

Ifekwunigwe (178) showed that malnourished children treated with skim milk had diarrhea more frequently and that they gained weight more slowly than those treated with a milk-casein-sucrose-oil mixture (K-Mix). Although the diarrhea could be related to the lactose content of the skim milk formula (about 3 times greater than the K-Mix formula) the poor growth can be partly, if not wholly, explained by its lower energy density (4 times lower than K-Mix).

Milk Feeding in Diarrheal Diseases

The soundness of using milk in patients with acute gastroenteritis has been questioned, since disaccharidase, and especially lactase activities can be depressed in these diseases (4, 65, 105, 126, 128, 131, 133) and the resulting lactose malabsorption may aggravate the diarrhea (9, 179). Recent studies (29, 30) have shown that cow's milk protein-sensitive enteropathy also prolongs diarrhea in infants with acute infective enteritis, at least partly due to a decrease in intestinal lactase, sucrase and maltase. The disaccharidase depression is transient and tolerance to milk is reinstated after the disease has been cured (127), but this may take some time and there are reports that the use of milk in children convalescing from a severe bout of gastroenteritis can prolong the diarrhea (129). This does not necessarily impair nutritional status nor growth rate according to various investigators (129), including Strickland, Garza and Nichols, who indicated at the 1979 meeting of the American Society for Clinical Nutrition that after an episode of diarrhea, infants fed a formula which contained lactose grew as well as those fed a sucrose formula, contrary to their preliminary observations published in the Abstracts of that meeting (180). Nevertheless, it is generally considered wise to interrupt or decrease the use of non-human milk products in acute gastroenteritis (128).

Breast feeding, however, *should not be discontinued.* There is no evidence of milk intolerance in breast-fed infants, even when afflicted by infectious diarrhea. Breast milk is, in fact, part of the treatment of infectious diarrhea in babies due to its immunological properties. If the loss of nutrients due to the diarrhea is combined with a decreased nutrient intake, as occurs when breast feeding is interrupted, the child's nutritional status will suffer. Furthermore, the interruption of breast feeding can lead to early weaning with its accompanying nutritional and health risks, especially among groups of a low socioeconomic status who frequently live in unsanitary environments.

Effect of Lactose Malabsorption on the Absorption and Retention of other Nutrients

The effects lactose malabsorption may have on the absorption and retention of other nutrients must be considered, especially in the context of children with marginal dietary intakes.

Most investigations on these effects have used aqueous solutions of lactose and few studies have been reported using milk. Paige and Graham (181, 182) reported increased fat and nitrogen contents in stools of lactose-intolerant children, and Leichter and Tolensky (183) informed a similar finding in rats. This type of observations has led some authors (72, 184) to suggest that milk may aggravate a deterioration in the nutritional status of lactose malabsorbers by impairing absorption of other nutrients from the diet. Several studies, however, do not support such conclusions. Bowie (170) fed either milk or a disaccharide-free formula to severely malnourished children. Those who had diarrhea while on milk had a lower absorption of nitrogen but their urinary excretion of nitrogen also decreased, so that retention ("balance") was unaffected; fat absorption was not affected by lactose-induced diarrhea. In another study, investigators from the same group (109) showed that lactose-induced diarrhea did not impair absorption of D-xylose, glucose, galactose, sucrose or maltose. Graham and Paige (181) found that nitrogen absorption decreased in lactose-intolerant children fed a lactose-containing formula with a lactose:protein proportion 2.3 times greater than cow's milk, but that it improved within 3-6 days. Nitrogen balance also improved after 6 days. These reports are in agreement with observations on healthy lactose-tolerant and -intolerant adults (157), in whom no effect on nitrogen balance was demonstrated after making adjustments for metabolizable energy.

Recent studies (185) using ileal perfusion techniques with normal and lactose-hydrolyzed milk showed that lactose did not alter nitrogen and fat absorption, although there was a greater loss of carbohydrates, calcium and magnesium through stools. The effect of lactose on calcium and magnesium absorption is unclear and there are several controversial reports, mainly based on animal experiments (186-189).

Use of Lactose-Hydrolyzed Milk

Although milk-induced diarrhea may be transient (190) and it affects mainly school-age or adolescent children and adults, some investigators (19, 165, 169, 191) have concluded that milk consumption should not be encouraged in lactose-intolerant populations due to adverse resultant symptoms. This has prompted research on several alternatives to the use of natural milk. One of such alternatives is cow's milk prehydrolyzed by lactase (58, 154, 176, 177, 192-194). The lactose-hydrolyzed milk was well accepted, produced higher blood sugar rises (119, 194), lower breath hydrogen (58), and less symptoms (192) than untreated milk, although some individuals had inconsistent results, reporting symptoms with a 90% hydrolyzed milk but not with a 50% hydrolyzed milk (154). Australian investigators concluded that lactose-hydrolyzed milk allowed better catch-up weight-gains than normal milk in malnourished and other sick children, mainly in those under one year of age and with diarrhea (176, 177), although in those studies it was not documented if dietary intakes or the pathological states of the children were comparable. In contrast, school-age children in Surinam grew better with normal than with hydrolyzed milk (161).

The use of lactose-hydrolyzed milk might be justifiable in those conditions when milk is not tolerated due to its lactose content, such as in the case of children with acute gastroenteritis or with intolerance to "physiologic" amounts of milk lactose. Its routine use for the treatment of PEM, at least in its initial stages, is debatable in view of the evidence of adequate recovery and growth with regular milk (99, 100, 170-172, 195) and more studies of the type conducted in Australian aborigines (176, 177) are needed under standardized conditions of dietary intakes and clinical evaluations. The nutritional advantage mentioned by Payne-Bose *et al.* (58) in relation to the need of less sucrose to make it sweeter is questionable, especially when dealing with undernourished populations: a relative disadvantage of milk is its low energy density, and the addition of sucrose – which might be hindered by the already sweet flavor of the lactose-hydrolyzed milk – is the most practical and commonly used measure to provide more energy to undernourished milk-fed children.

The benefical effects of hydrolyzed milk in food distribution programs and in the treatment of PEM must be compared with those of other alternatives, such as the mixing of normal milk with other protein and energy sources (e.g., K-Mix (178)), or the use of formulas based on vegetable proteins. A cost-benefit analysis must be included in addition to the nutritional evaluations. Furthermore, the suggestion that cow's milk protein may impair the digestion and absorption of disaccharides and also of monosaccharides in sensitive diarrheic children (29, 30), reinforces the need to investigate the advantages of lactose-hydrolyzed milk relative to vegetable-based lactose-free formulas during the treatment of children with infectious diarrhea and, possibly, of PEM-related severe diarrhea.

CONCLUSIONS AND RECOMMENDATIONS

The position of the authors of this document in relation to lactose intolerance and to the nutritional uses of milk is stated in the conclusions and proposed recommendations described below. These were based on their clinical, experimental and public health experience, and on the literature survey presented in the preceding sections of the document.

1. Most of the evidence published indicates that milk is well tolerated by children, especially infants and those of preschool age, and that it has a high nutritional value.

2. The difference between primary (genetic) and secondary (acquired) lactose malabsorption must be borne in mind when the use of milk is considered. The former is a genetic, age-related, permanent trait, usually not accompanied by intolerance to physiologic amounts of milk. The latter is usually transient (e.g., secondary to infectious gastroenteritis or to severe PEM) and associated to milk intolerance more frequently than primary lactose malabsorption.

3. Lactose malabsorption or intolerance, as established after an oral dose of 2 g lactose/kg of body weight in a concentrated aqueous solution, is not necessarily indicative of intolerance to the amounts of milk and other dairy products which most people ingest in a meal. The following measures are suggested to assess intolerance to milk and other lactose-containing foods under physiological and nutritional points of view:

a) The test dose should be of the order of the lactose content ordinarily ingested in a meal. We suggest 2 g/kg to a maximum of 12 g during the first year of age; 15 g during the second year; and 18 g thereafter.

b) Whole cow's milk should be the vehicle for lactose since the nutritional concern about lactose malabsorption and/or intolerance is related to the ingestion of dairy products and not of its carbohydrate component. To ensure the complete ingestion of the test dose, "concentrated" cow's milk can be prepared for small children using less water to dilute powdered-dried milk. If assessment of the specific role of the disaccharide in persons with milk absorption is desired, the test dose should be mixed with other nutrients, particularly proteins and fat. The relative contents of those nutrients in cow's milk can be used as the standard (5 g lactose, 3 g non-milk protein and 4 g vegetable oil per 100 ml). The accompanying use of solid or semi-solid ingredients should be considered for children over 5 years of age and for adults.

c) The analysis of breath hydrogen is, at present, the method of choice for the objective evaluation of milk-lactose *malabsorption,* although the pitfalls in its use, previously described in this document, must be taken into account. Simpler measures such as stool pH, reducing substances in stools and plasma glucose rises, have poor specificity and low sensitivity to malabsorption of *physiological* doses of lactose ingested as a food and their results are highly variable. However, the combination of pH and reducing substances in stools can be considered when breath hydrogen cannot be analyzed. It should be remembered that breast-fed infants normally have acidic stools and some fecal excretion of lactose.

d) Except in case of infants and very young children, the test dose should be administered in a double-blind fashion or at least with the lactose disguised and preceded or followed by a lactose-free preparation of indentical appearance. Otherwise, the evaluation of symptoms and the diagnosis of lactose *intolerance* are highly unreliable.

4. The use of cow's milk should not be discouraged in the treatment of malnourished children unless cheaper, practical sources of high-quality protein are available. It must be borne in mind, however, that on a few occasions a child may require a diet free of, or low in lactose to recover adequately (e.g., cases of "true" intolerance or with accompanying severe diarrhea). Vegetable proteins or mixtures of high nutritional quality or lactose-hydrolyzed milk with a high energy density are suitable alternatives. In any event, milk should be reintroduced to the diet for a reasonable trial period (i.e., several days) as the child recovers, before diagnosing him as "intolerant to milk".

5. It is convenient to interrupt or decrease the use of non-human milk products during episodes of severe diarrhea. The low lactose- or lactose- free substitutes must have adequate energy and protein contents to prevent nutritional deterioration. Milk should be reintroduced gradually in the diet during convalescense.

6. Breast feeding *should not be discontinued* in children with diarrhea, unless intolerance to human milk with a

deterioration in nutritional status can be clearly demonstrated.

7. The use of milk or milk-containing foods ***should not be discouraged*** in food supplementation programs, even among population groups with a high prevalence of primary lactose malabsorption, except if other foods of high nutritional value are more easily accepted by the recipients, more available, less expensive or easier to prepare. Such programs, however, should consider the following:

a) Milk should not be the *only* element in food distribution programs, except when provided to already weaned infants under 6 months of age.

b) Whole milk should be used in such programs. When dried skim milk is used, its energy content must be augmented by adding carbohydrates and vegetable oil to provide an energy density at least equal to that of whole cow's milk.

c) When the recipients are undernourished children, other foods must accompany the milk or other ingredients must be added to it in order to increase the total energy intake to at least 100 Kcal per the equivalent of 100 ml of fluid milk.

d) Adequate instructions must be given to prepare, consume and store the supplements under good hygienic conditions.

e) Except under disaster relief conditions, or when a high prevalence of malnutrition among older children is adequately documented, milk distribution should be aimed primarily at infants and preschool-age children. Milk distribution is most likely to be successful in children below 5 years of age, as the prevalence of PEM is highest in this age group and lactose malabsorption –even with pharmacological doses of substrate– is rare before 3-5 years. Cheaper and more practical alternatives to milk are usually available for food supplementation programs for older children, pregnant or lactating women, and the population-at-large.

8. The nutritional, economic and technical advantages of lactose-hydrolyzed milk should be evaluated further and compared with those of natural (i.e., lactose-containing) milk and other products of high nutritional quality. More research of the type carried out in Australian hospitalized patients (176, 177) and in Bushnegro school children from Surinam (161) must be conducted. Such investigations should include:

a) A non-dairy protein source in addition to normal and lactose-hydrolyzed milk.

b) Exact measurements of food intake, including the quantification of any substitution effects on the home diet in population studies.

c) Groups of patients who are comparable in terms of nutritional status, hydration and other pathological and physiological conditions, and/or groups of healthy individuals who are equally comparable.

d) Functional assessments, such as growth rates of children, complemented with diagnostic tests of malabsorption and/or intolerance in order to use such tests as predictors of the functional changes, if they are shown to correlate adequately.

e) Periods of observation which are long enough to assess growth rates of children, and well-defined standardizations of the measurements to account for intra- and inter-individual variabilities.

f) Analyses of acceptability, cost and ease of preparations of the various nutritional interventions.

CONCLUSIONES Y RECOMENDACIONES

Las conclusiones y recomendaciones siguientes definen la posición de los autores en relación a la intolerancia a lactosa y a los usos nutricionales de leche. Están basadas en su experiencia clínica, experimental y de salud pública, y en la revisión de la literatura científica citada en este documento.

1. La mayor parte de las publicaciones indican que la leche es bien tolerada por los niños, particularmente por los infantes y los de edad preescolar, y que tiene un alto valor nutricional.

2. Cuando se considere el uso de la leche debe tenerse en mente la diferencia entre la malabsorción primaria (genética), y la secundaria (adquirida), de la lactosa. La primera es una característica genética, permanente, relacionada con la edad, que raras veces se acompaña de intolerancia a cantidades fisiológicas de leche. La segunda es generalmente transitoria (por ejemplo, secundaria a gastroenteritis infecciosa o a desnutrición proteínico-energética severa), y se asocia a intolerancia a la leche con mayor frecuencia que la malabsorción primaria de lactosa.

3. La malabsorción o intolerancia a la lactosa, determinada por la ingestión de una dosis de 2 g de lactosa/kg de peso corporal en una solución acuosa concentrada, no indica necesariamente

intolerancia a las cantidades de leche y de otros productos lácteos que la mayor parte de la gente ingiere en una comida. Para evaluar en términos fisiológicos y nutricionales la intolerancia a la leche o a otros alimentos que contengan lactosa, se sugiere lo siguiente:

a) La dosis de prueba debe ser similar a la cantidad de lactosa que usualmente se ingiere en una comida. Se sugiere usar 2 g/kg de peso hasta un máximo de 12 g de lactosa durante el primer año de vida: 15 g durante el segundo año, y 18 g después de esa edad.

b) El vehículo usado para la lactosa debe ser leche íntegra de vaca, ya que la preocupación nutricional relacionada con la malabsorción y/o intolerancia a la lactosa está relacionada con la ingestión de productos lácteos y no con la ingestión del carbohidrato puro. Para asegurar que la dosis de prueba será ingerida en su totalidad por niños pequeños, puede prepararse leche de vaca "concentrada" usando menor cantidad de agua para diluir la leche en polvo. Cuando se desee establecer el papel específico que el disacárido juega en aquellas personas con malabsorción de leche, la dosis de prueba deberá mezclarse con otros nutrientes, especialmente proteínas y grasas. El contenido relativo de esos nutrientes en la leche de vaca podría usarse como el estándar (5 g de lactosa, 3 g de proteína no láctea, y 4 g de aceite vegetal por cada 100 ml). Debe considerarse el uso adicional de ingredientes sólidos o semisólidos en las pruebas que se hagan en niños mayores de 5 años y en adultos.

c) En la actualidad, el análisis de hidrógeno en aire espirado es el método de elección para la evaluación objetiva de *malabsorción* de lactosa de leche. Sin embargo, según se describe en este documento, tiene ciertos inconvenientes que deben tomarse en consideración. Las medidas más sencillas, tales como la determinación del pH fecal y de substancias reductoras en heces, así como el incremento en los niveles de glucosa plasmática son poco específicas, tienen una baja sensibilidad para detectar malabsorción de dosis *fisiológicas* de lactosa ingerida como parte de un alimento, y sus resultados son sumamente variables. No obstante, cuando las circunstancias no permiten hacer determinaciones de hidrógeno en aire espirado, se puede considerar el uso de la combinación del pH y la presencia de substancias reductoras en las heces. Debe recordarse que los niños alimentados al seno materno normalmente tienen heces ácidas y excretan cierta cantidad de lactosa en las mismas.

d) Excepto en el caso de infantes y niños muy pequeños, la dosis de prueba debe administrarse en forma doblemente ciega o, por lo menos, disfrazando su contenido de lactosa; esta dosis de prueba debe ser precedida o seguida por una preparación libre de lactosa con la misma apariencia. De lo contrario, es poco confiable la evaluación de los síntomas y el diagnóstico de *intolerancia* a lactosa.

4. No debe evitarse el uso de la leche de vaca en el tratamiento de niños desnutridos, a menos que se disponga de otras fuentes prácticas y más baratas de proteínas con alto valor biológico. Debe considerarse, sin embargo, que en algunas ocasiones un niño puede requerir una dieta sin o pobre en lactosa para recuperarse adecuadamente (por ejemplo, casos de intolerancia "verdadera" o con diarrea severa). Las proteínas o mezclas vegetales de alta calidad nutricional y leche con lactosa pre-hidrolizada y de alta densidad energética, son alternativas adecuadas. En todo caso, antes de diagnosticar a un niño como "intolerante a la leche", este alimento debe reintroducirse en su dieta durante un período de prueba lo suficientemente largo, es decir de varios días, a medida que el niño se recupere.

5. Es conveniente interrumpir o reducir el uso de productos lácteos, no humanos, durante períodos de diarrea severa. Los alimentos sin, o pobres en lactosa, que se usen como sustitutos deben aportar cantidades adecuadas de energía y proteínas para evitar el deterioro nutricional. La leche debe reintroducirse gradualmente en la dieta durante la convalecencia.

6. La lactancia materna *no debe descontinuarse* en niños con diarrea, a menos que se compruebe claramente intolerancia a la leche humana, con deterioro del estado nutricional.

7. *No debe evitarse* el uso de leche o de alimentos que contengan leche en programas de suplementación alimenticia, aun entre grupos de población con alta prevalencia de malabsorción primaria a la lactosa, salvo si otros alimentos de alto valor nutricional son mejor aceptados por los recipiendarios, más disponibles, menos caros o más fáciles de preparar. No obstante, tales programas deben considerar lo siguiente:

a) La leche no debe ser el único ingrediente en los programas de distribución de alimentos, excepto en el caso de niños menores de 6 meses de edad que ya hayan sido destetados.

b) Se debe utilizar leche *íntegra* en tales programas. Cuando se use leche descremada en polvo se debe aumentar su contenido energético mediante la adición de carbohidratos y aceite vegetal, a fin de suministrar una densidad energética por lo menos igual a la de la leche íntegra de vaca.

c) Cuando los recipiendarios son niños desnutridos, la leche debe acompañarse de otros alimentos u otros ingredientes para aumentar su ingesta energética total a por lo menos 100 Kcal por el equivalente de 100 ml de leche fluida.

d) Se debe dar instrucciones para la preparación, el consumo y la conservación de los suplementos bajo condiciones higiénicas adecuadas.

e) La distribución de leche debe dirigirse primordialmente a infantes y niños de edad preescolar, excepto en casos de desastre o cuando se haya documentado una alta prevalencia de desnutrición entre niños mayores. Es probable que la distribución de leche tenga más éxito en niños menores de 5 años de edad, ya que la prevalencia de desnutrición proteínico-energética es más alta en este grupo etario y la malabsorción de lactosa –aun con dosis farmacológicas del substrato– es rara antes de los 3-5 años de edad. Generalmente existen alternativas más baratas y prácticas para utilizar en programas de suplementación alimentaria dirigidos a niños mayores, mujeres embarazadas y lactantes, y la población en general.

8. Las ventajas nutricionales, económicas y técnicas de la leche con lactosa pre-hidrolizada deben someterse a más evaluación y compararse con las de leche natural (es decir, que contiene lactosa) y con otros productos de alta calidad nutricional. Deberían realizarse más investigaciones como las efectuadas en pacientes australianos hospitalizados (176, 177) y en escolares de Surinam (161). Tales investigaciones deben incluir:

a) Una fuente no láctea de proteínas, además de la leche natural y la leche pre-hidrolizada.

b) Mediciones precisas de la ingestión alimenticia total, incluyendo cuantificación de los posibles efectos de sustitución en la dieta hogareña.

c) Grupos de pacientes que sean comparables en términos de estado nutricional, hidratación y otras condiciones patológicas y fisiológicas, y/o grupos de individuos sanos igualmente comparables.

d) Evaluaciones funcionales, tales como la de velocidad de crecimiento en niños, complementadas con pruebas diagnósticas de malabsorción y/o intolerancia, con el objeto de poder usar tales pruebas como predictoras de cambios funcionales en el futuro, si es que se muestra que hay correlaciones adecuadas.

e) Períodos de observación lo suficientemente largos como para evaluar la velocidad de crecimiento de los niños, y una estandarización bien definida de las medidas para poder tomar en cuenta las variabilidades intra- e inter-individuales al interpretar los resultados.

f) Análisis de aceptabilidad, costo y facilidad en la preparación de las diversas intervenciones nutricionales usadas en el estudio.

RESUMEN

MALABSORCION E INTOLERANCIA A LA LACTOSA: IMPLICACIONES PARA EL CONSUMO GENERALIZADO DE LECHE

Se revisó un total de 194 artículos publicados en relación a la malabsorción e intolerancia de lactosa. La baja correlación entre malabsorción de lactosa e intolerancia a las cantidades de leche usualmente ingeridas en una comida indica que se ha exagerado al asumir intolerancia a la leche por parte de muchas poblaciones. Se analizaron en forma crítica los métodos para diagnosticar estas condiciones, y se sugiere que: a) se usen dosis "fisiológicas" de lactosa; b) se use leche como el vehículo de elección; c) las pruebas de intolerancia sean "doblemente ciegas", y d) se analice el hidrógeno en aire espirado en pruebas de malabsorción. La mayoría de las publicaciones indican que el consumo de leche permite el crecimiento adecuado de niños, aun cuando estén desnutridos y tengan diarrea. No obstante, es aconsejable sustituir temporalmente la leche por otras fuentes adecuadas de proteínas y energía durante episodios de diarrea severa, y reintroducir la leche en la dieta gradualmente, en la convalecencia. La lactancia materna, sin embargo, no debe ser interrumpida. No hay suficiente apoyo científico ni epidemiológico que justifique evitar el uso de leche en programas de suplementación alimenticia, pero sí se señalan varios aspectos que se deben considerar en tales programas. (Las conclusiones y recomendaciones generales se presentan tanto en inglés como en español).

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